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Novel approach for the creation of photocatalytic thin films by plasma curing of TiO2 containing dispersions of non-reactive siloxanes

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Photocatalytic TiO_2 layers are industrially applied by PVD or CVD processes. For anatase-rich coatings substrate temperatures >280°C are required. As a consequence the PVD/CVD technique is limited to heat resistant substrates. In addition, the coating of complex 3D geometries by PVD techniques is limited. On the opposite, low pressure plasma polymerisation as cold coating process for 3D shaped components is available, but this technique is not suited for deposition of photocatalytic active TiO_2.
A new approach is presented merging the advantages of a low pressure plasma process and the incorporation of particles for surface functionalization. In a first step of this plasma hybrid coating technology a thin liquid film containing sub-micro TiO_2 particles is applied to the substrate. Different concepts for the application of the dispersions were investigated including spin coating for 2D geometries and aerosol deposition for 3D geometries respectively. In a second step the liquid dispersion is cross-linked in a low pressure plasma process by a photochemical-induced conversion of the liquid siloxane. As a result a mechanically stable SiO_2-like matrix is generated containing particles with a diameter up to several times of the average coating thickness. Although the TiO_2 particles are covered partly by a thin matrix layer of several nanometer photocatalytic activity is clearly observed.
A characterization of the stabilized anatase-rich nano TiO_2 dispersion as well as experimental results and limits of the plasma process will be presented. Furthermore, the properties of the coating as well as the results of the photocatalytic degradation of methylene blue will be discussed with special regard to the matrix coverage. A process conform strategy by CF_4 plasma etching for the enhancement of the photocatalytic activity will be proposed. The advantages of the novel technology become apparent for temperature-sensitive material as well as for complex 3D geometries. A first application on coating micro scaled channels of a micro-reactor will be shown.

Keywords
Plasma curing
TiO2
Micro-reactors
Photocatalytic activity
Plasma etching